Improving Photometric Calibration of Meteor Video Camera Systems

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Introduction

Current optical observations of meteors are commonly limited by systematic uncertainties in photometric calibration at the level of ~ 0.5 mag or higher. Future improvements to meteor ablation models, luminous efficiency models, or emission spectra will hinge on new camera systems and techniques that significantly reduce calibration uncertainties and can reliably perform absolute photometric measurements of meteors.

In this talk we discuss the algorithms and tests that NASA's Meteoroid Environment Office (MEO) has developed to better calibrate photometric measurements for the existing All-Sky and Wide-Field video camera networks as well as for a newly deployed four-camera system for measuring meteor colors in Johnson-Cousins $BVRI$ filters. In particular we will emphasize how the MEO has been able to address two long-standing concerns with the traditional procedure, discussed in more detail below.

1 Photometry in an Arbitrary Bandpasses

The All-Sky and Wide-Field camera networks are sensitive to a significantly broader range of wavelengths than a typical Johnson or Sloan filter. Subsequently calibration models that determine zero-points of reference stars in an unfiltered video camera relative to observations taken in a standard astronomical filter will be subject to large color terms that are not accounted for. In order to circumvent the need for large and uncertain color terms, we have used the SAO J2000 catalog to create a network of fully calibrated reference stars in the camera response band. This method can be applied to an arbitrary bandpass and enables direct calculations of the meteor flux in physical units.

2 Laboratory Tests of Camera Linearity

Accurate calibration of meteor photometry demands a robust understanding of the camera linearity in order to properly compare the fluxes of bright and faint meteors or meteors detected in two cameras independently. We discuss a simple, inexpensive laboratory experiment that quickly and accurately samples the response curve of a video camera which has been validated against independent tests in NASA's video calibration laboratory. These tests show precisely how the response of a standard meteor video camera varies as the gain and gamma settings are adjusted across its entire dynamic range.

3 Testing and Performance

Applying these new methods to new and existing data enable video photometry of unsaturated meteors accurate to ~ 0.10 mag. A large component of this uncertainty arises from deficiencies in our bandpass modeling. Crucially, there is no evidence for any additional systematic errors or uncertainties that depend on either the magnitude or the color of the reference stars. We will conclude by discussing potential improvements to these methods in the future.